

The identification of algal symbionts in corals:  
biodiversity, evolution and host symbiont specificity.

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What is a coral?

In the tropics, the scleractinia are composed of two extremely different organisms

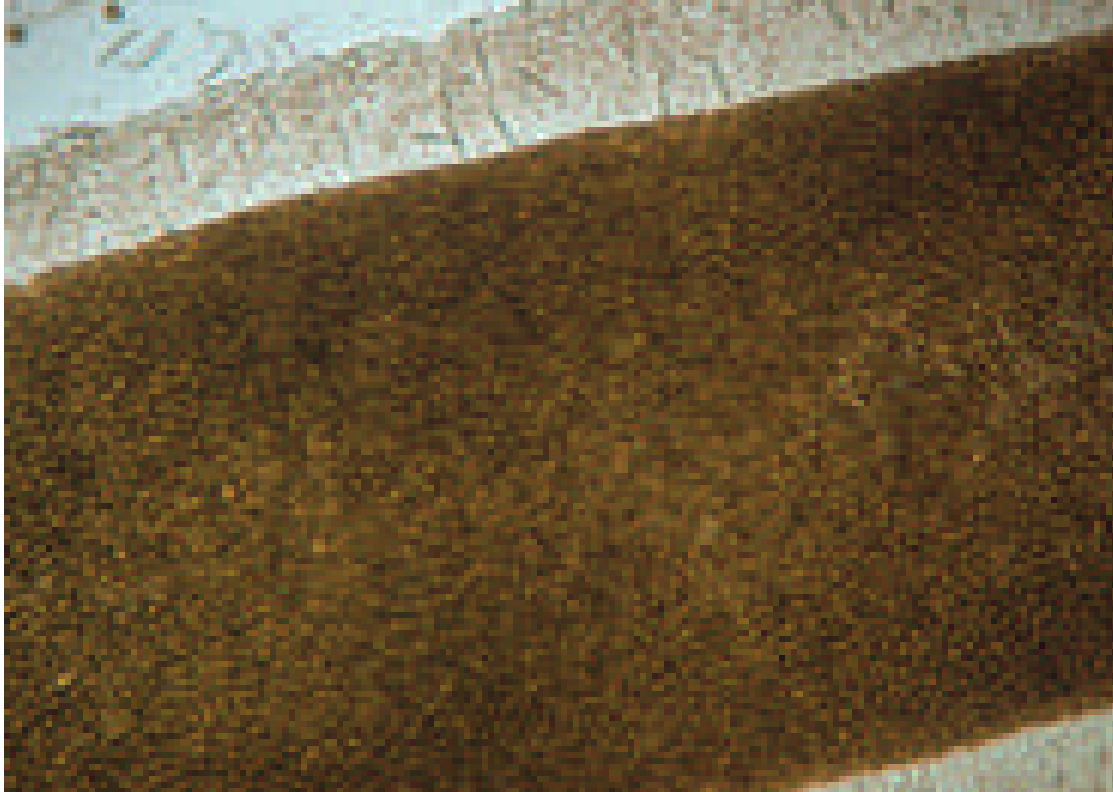


# The monster or super organism

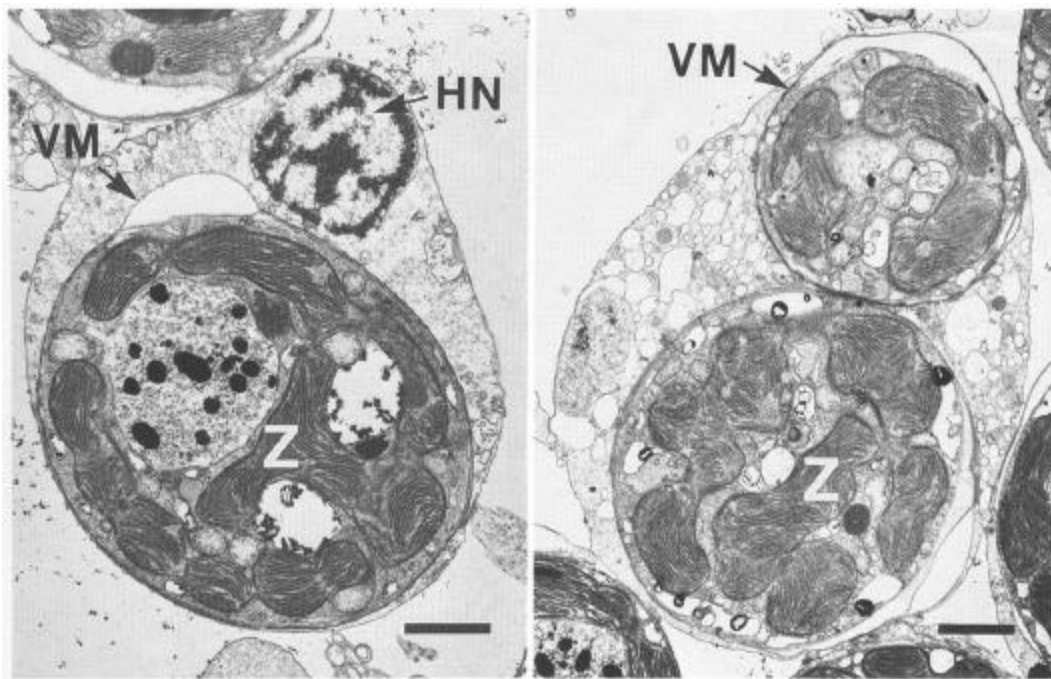
epidermis



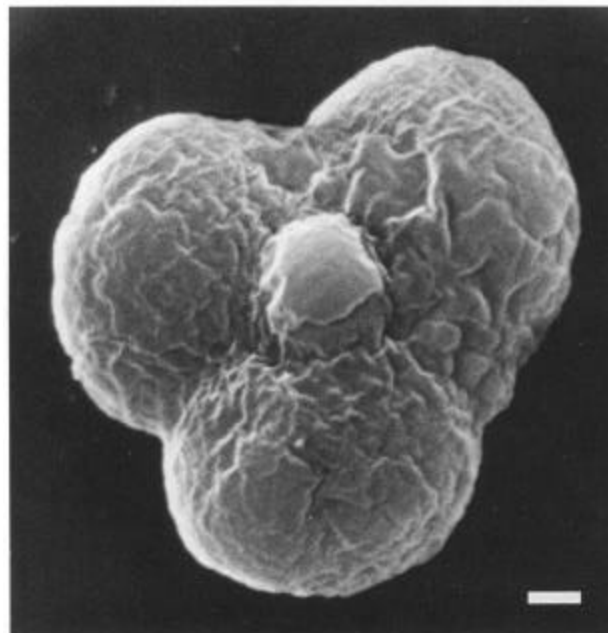
endodermis



polyp tentacle



**Fig. 5.** Transmission electron micrographs of isolated *P. damicornis* endoderm cells containing one (left) and two (right) zooxanthellae. Scale bar = 2  $\mu$ m. HN = host nucleus; VM = vacuolar membrane



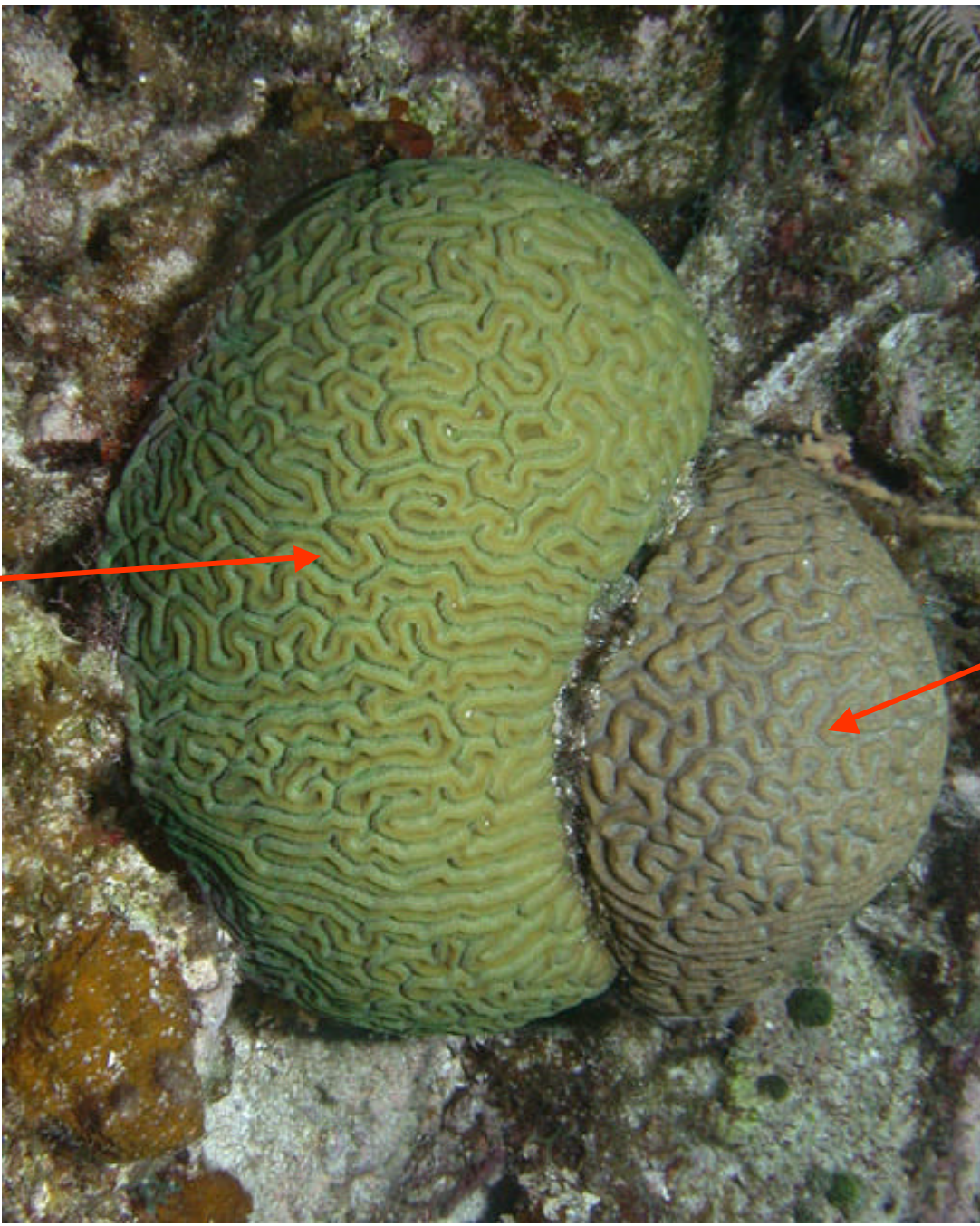
**Fig. 4.** A scanning electron micrograph of an isolated *A. pulchella* endoderm cells containing three zooxanthellae. Scale bar = 1  $\mu$ m

# Ecology

“No thorough ecological survey can be conducted without the most painstaking identification of all species that are of ecological significance.”

- (Mayr & Ashlock 1991)

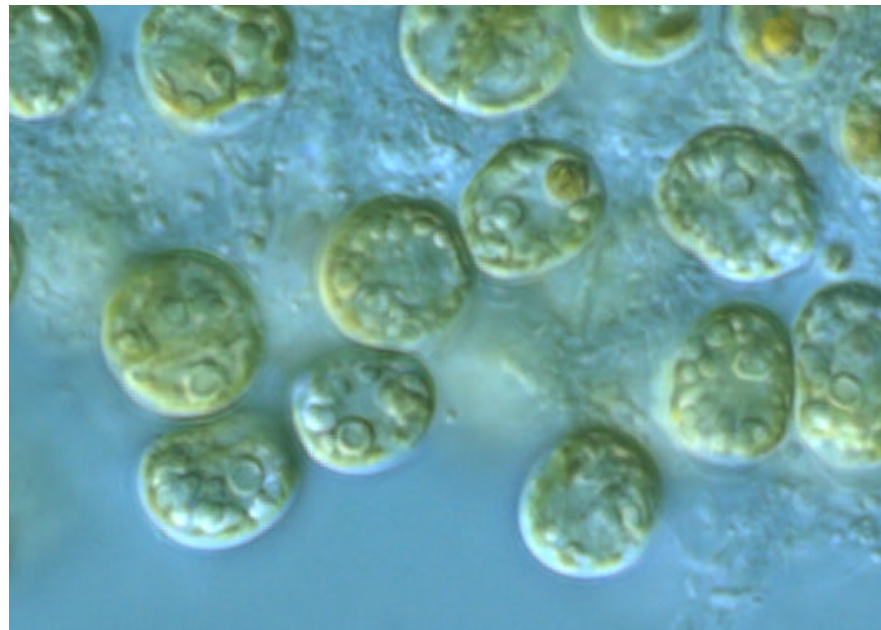
*Diploria labyrinthiformis*



*Diploria strigosa*



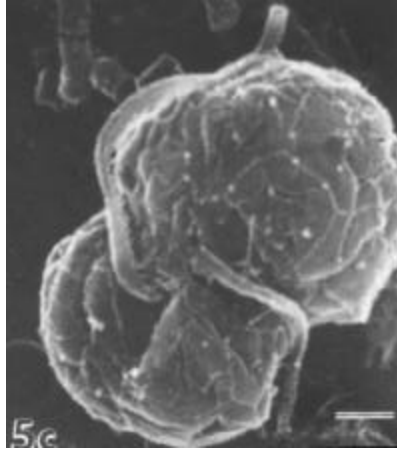
# Identifying the dinoflagellate symbiont



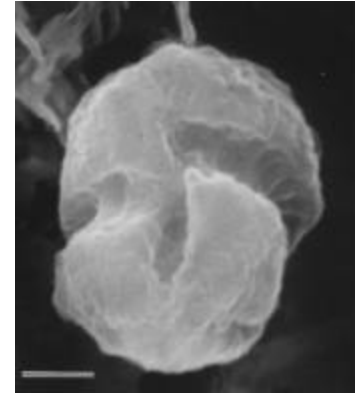


R. K. Trench

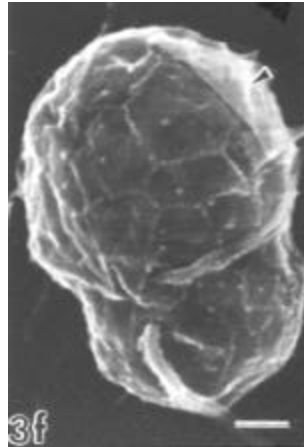
# Dinoflagellates in the genus *Symbiodinium*



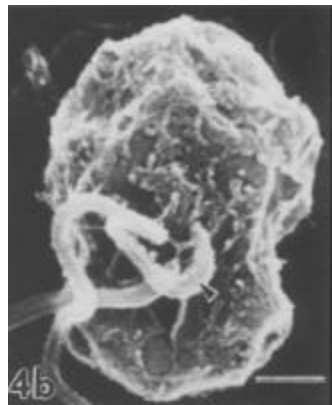
*S. pilosum*



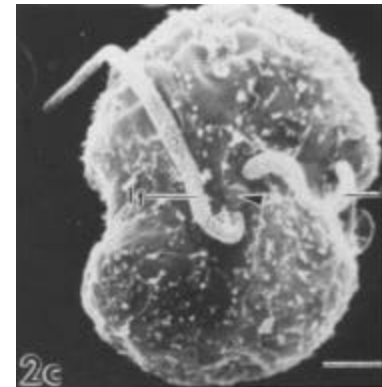
*S. (= Gymnodinium) linucheae*



*S. goreau*



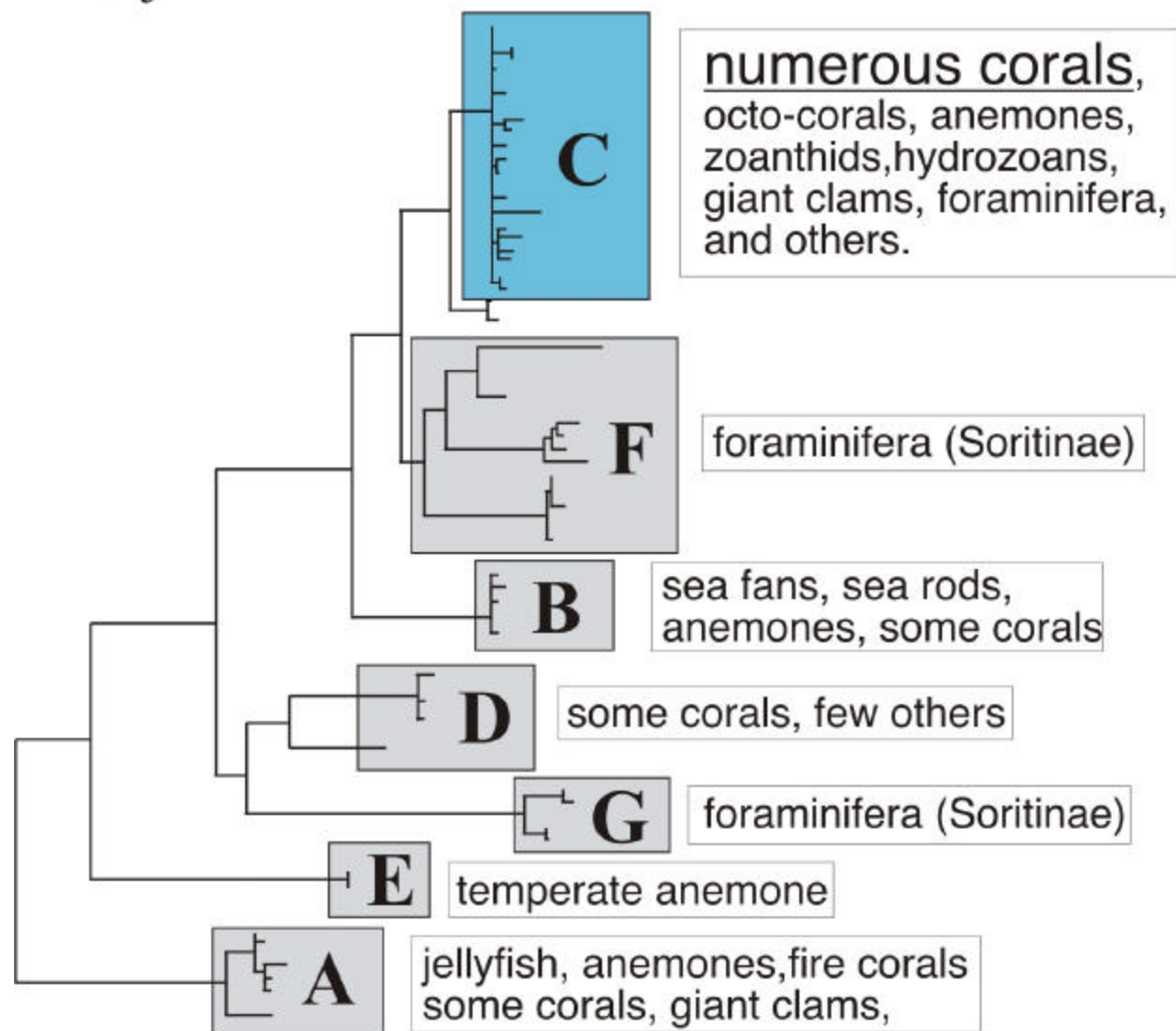
*S. kawagitii*



*S. microadriaticum*

# *Symbiodinium*

## Host taxa



# Species concept for Symbiodinium:

Genetically very similar

- as determined by gene sequence comparisons

physiologically similar

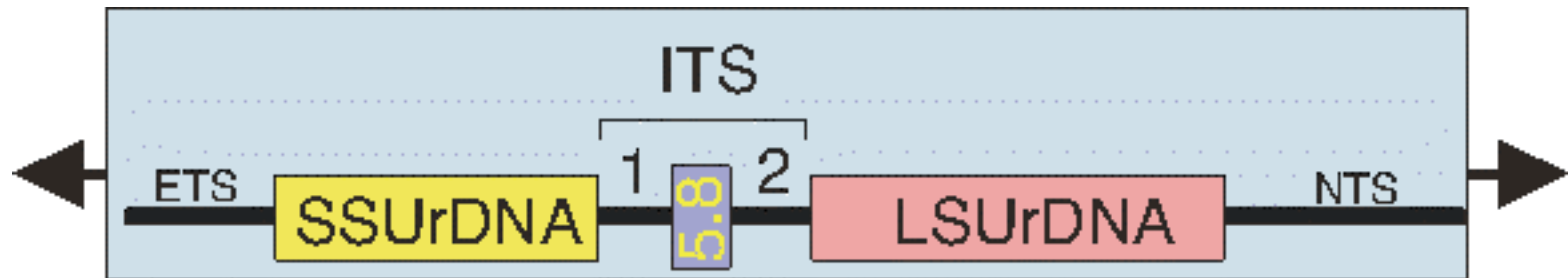
- comparative work with cultures and *in hospite*

occupy the same ecological niche

- inferred from associations with particular host taxa

The ribosomal ITS region is an informative “ species” level marker

## A genetic marker of ecological relevance



100's to 1000's of copies



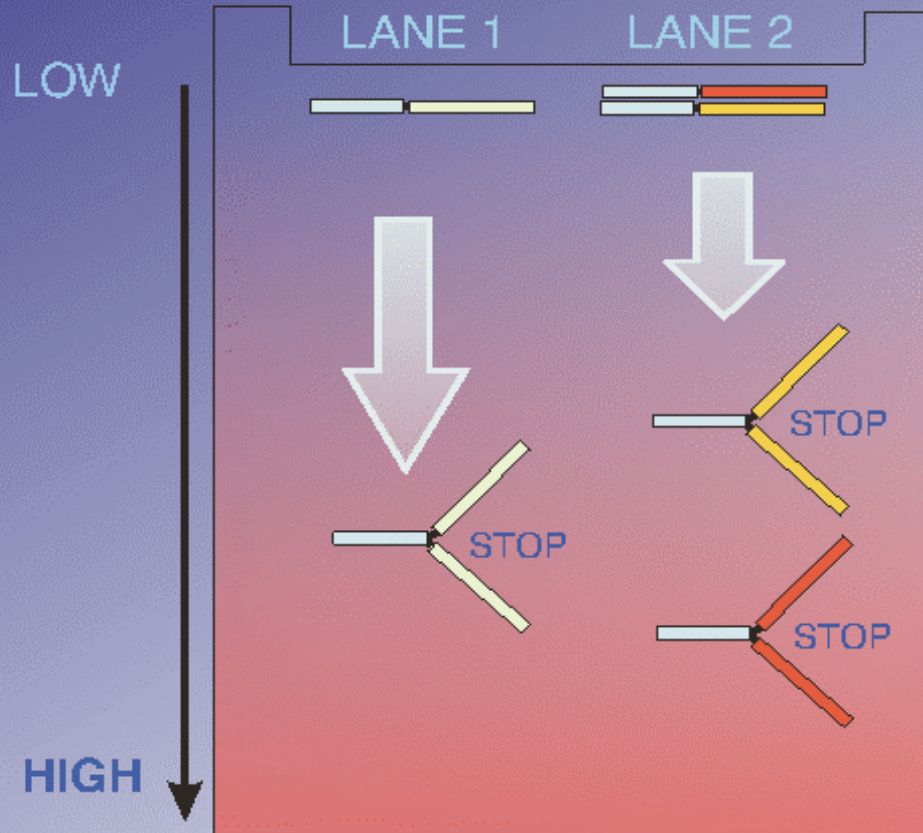
# Denaturing Gradient Gel Electrophoresis

## 1. DNA EXTRACTION

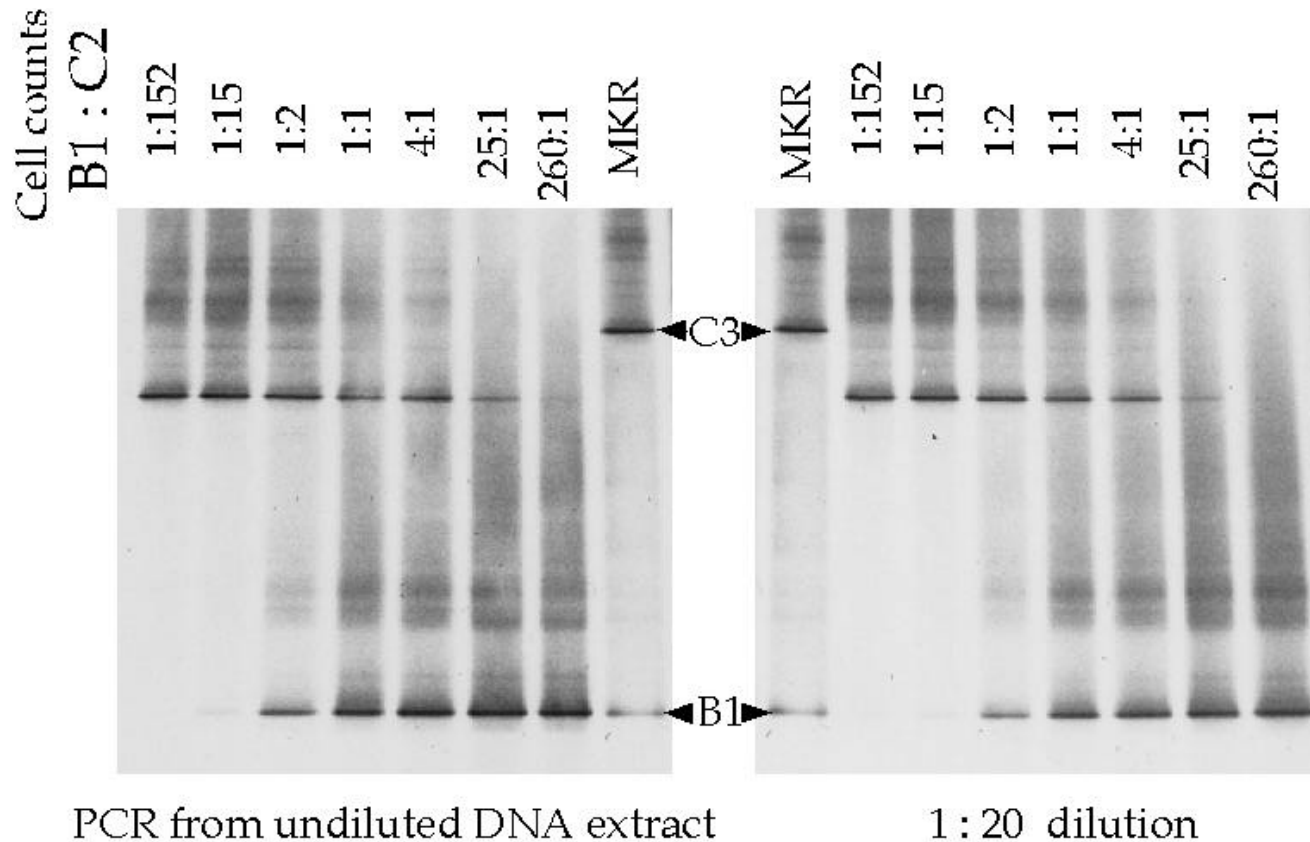
## 2. PCR

GC-CLAMP GENE SEQUENCE  
...GCCGCCG-Primer — ITS 2

## 3. LOAD+RUN



# Sensitivity of DGGE in resolving multiple symbiont types.



Can detect a second type is it represents 3-4% of the population

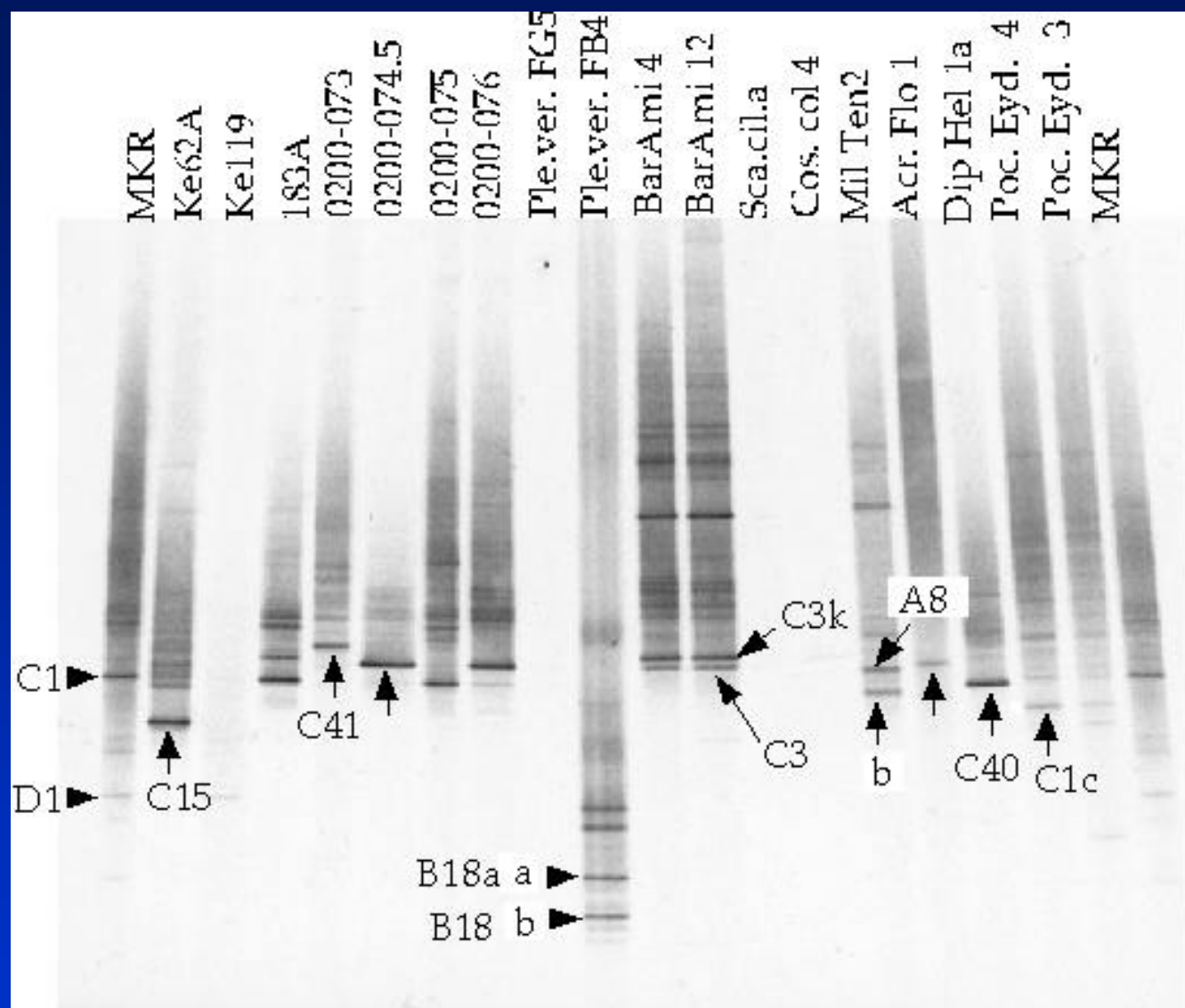


A SUPERB SPECIMEN...  
SYMBOL OF AGELESS BEAUTY  
AND FRAGILITY OF  
LIFE!... UNDISTURBED  
HERE FOR THOUSANDS  
OF YEARS...  
HAND ME THE  
CHISEL.

- WE'LL NEED  
REPLICATES.

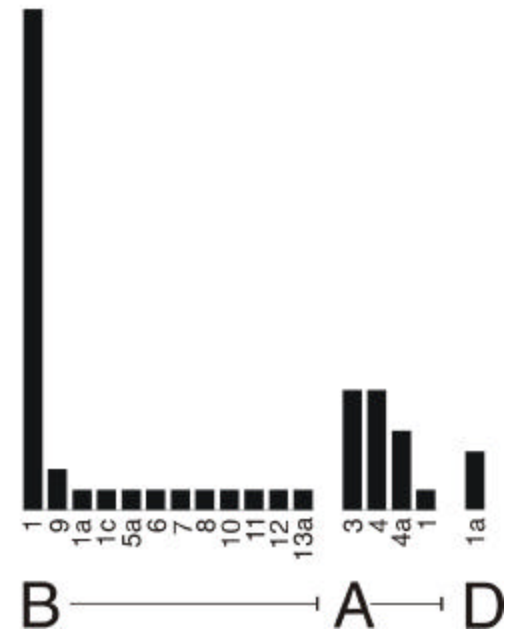
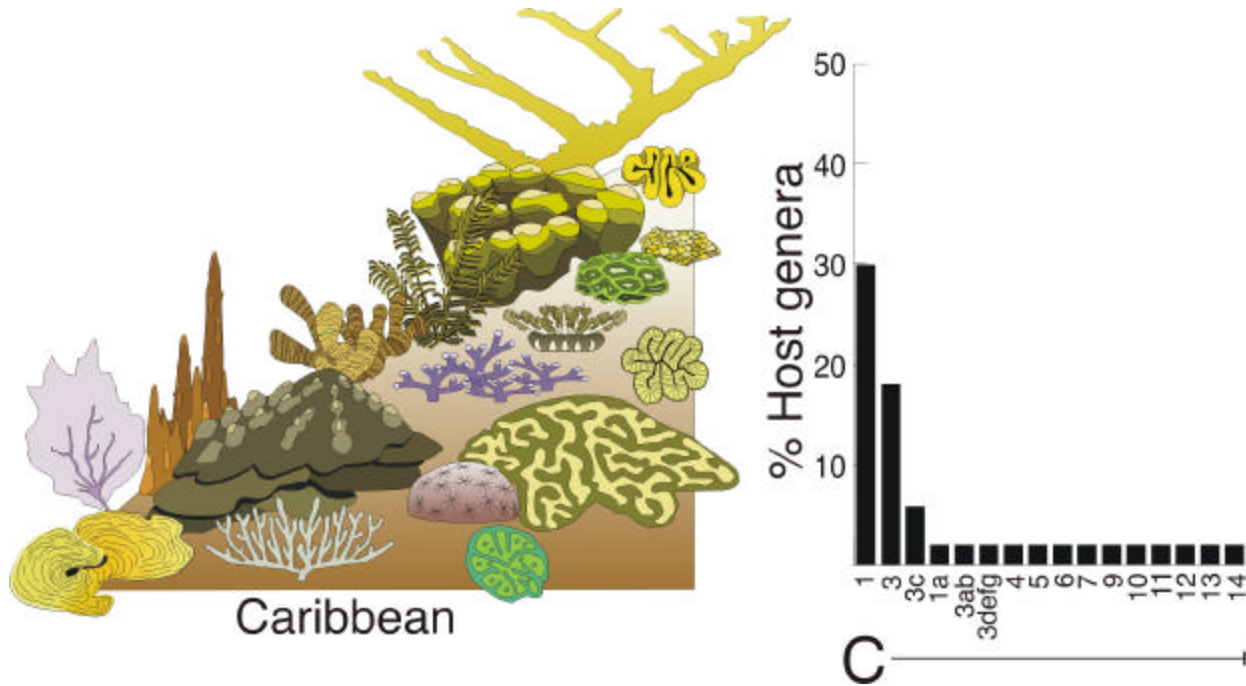


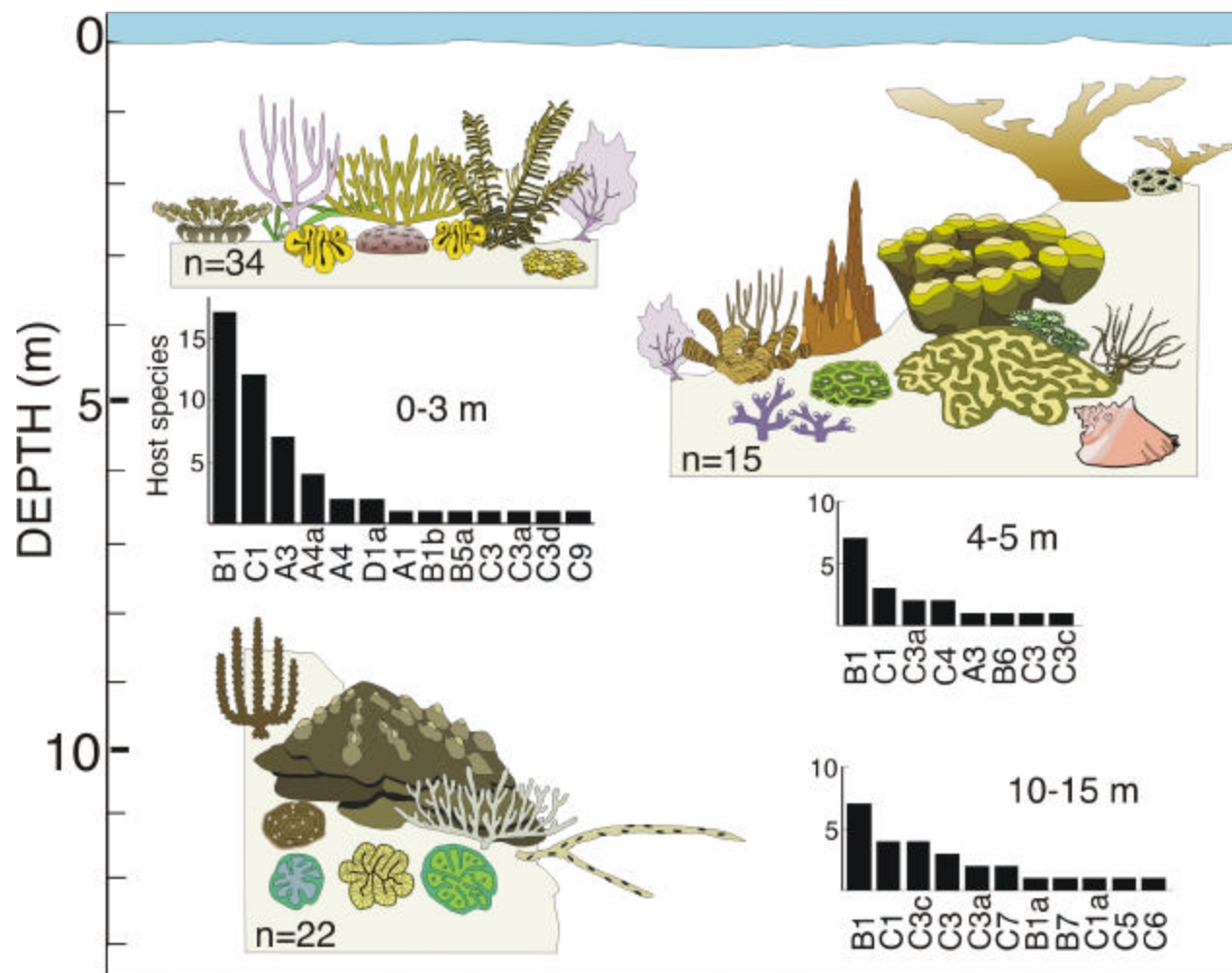




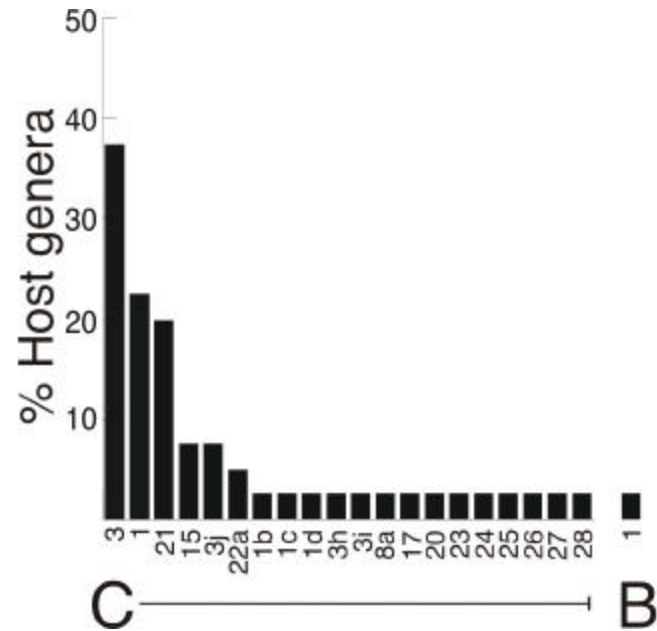


# Symbiont community structure in the Caribbean

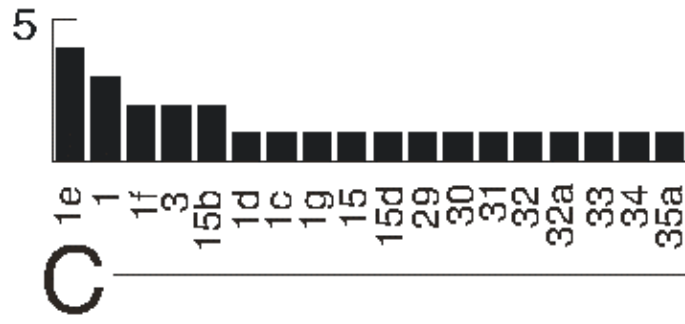




# Symbiont community structure in the Southern GBR



# Host genera



**B**

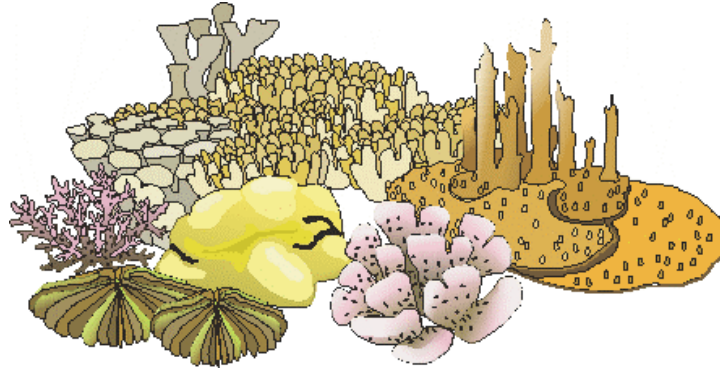
Category	# Host genera
1	1

**A**

Category	# Host genera
3	3

**D**

Category	# Host genera
1a	1
1	1



Hawaii

# Surveys of *SYMBIODINIUM* diversity and distribution.

assesses biodiversity at:

- zonal (e.g. patch reef vs. fore reef)
- local (e.g. reef-wide)
- regional (e.g. Caribbean)

and global scales.

Deduction of ecological interactions and evolutionary processes

- assesses the range of host-symbiont specificity.
- provide insight into how these systems have responded in the past to climatic perturbations

This information then can be incorporated into a model to predict how coral reef cnidarians will respond to major climatic change.

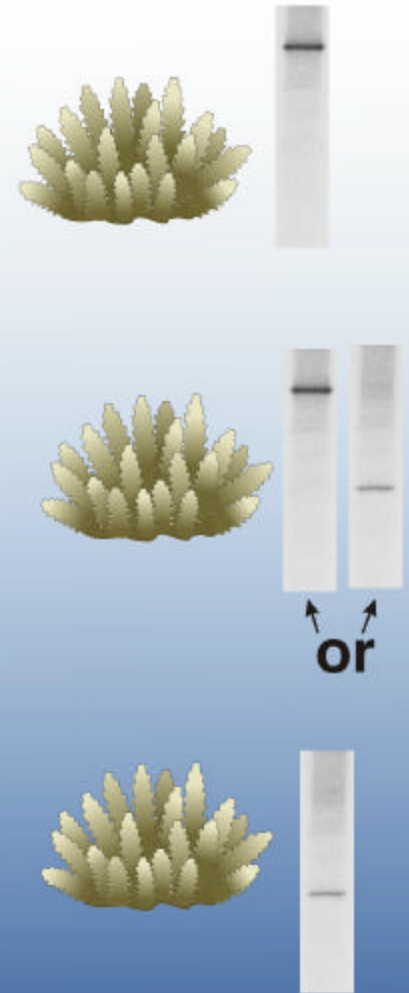
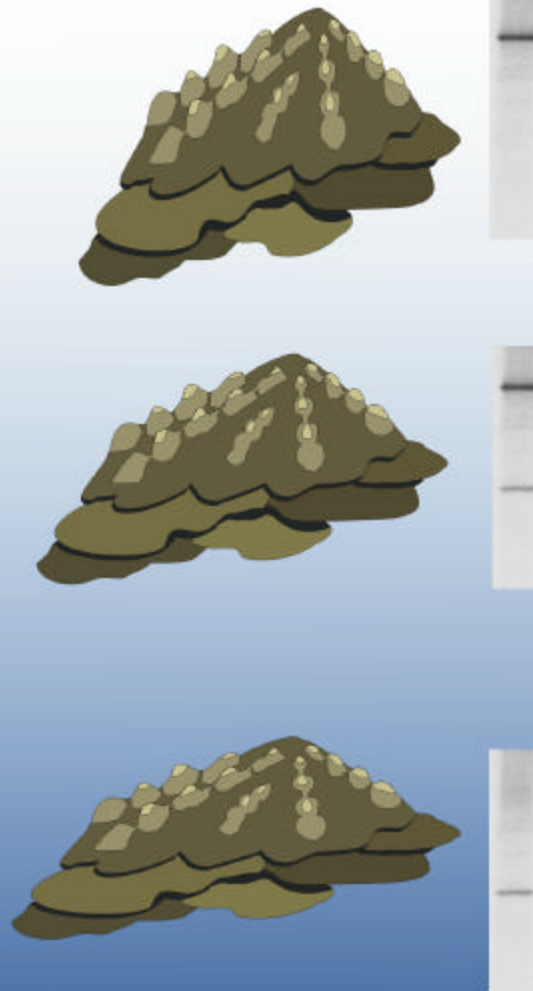
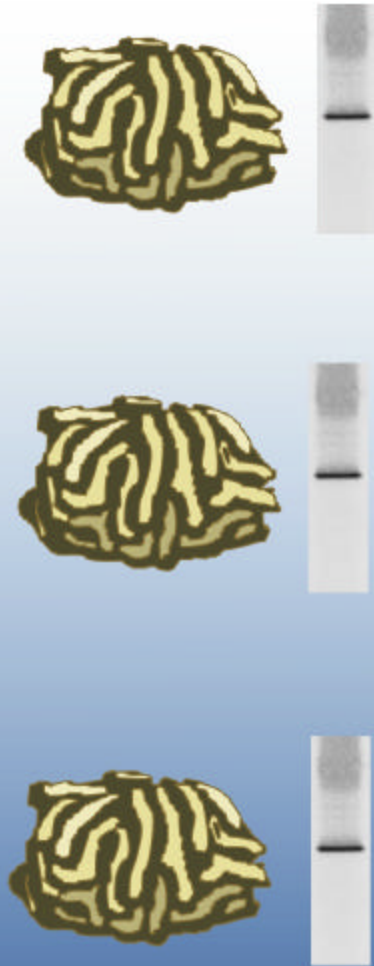


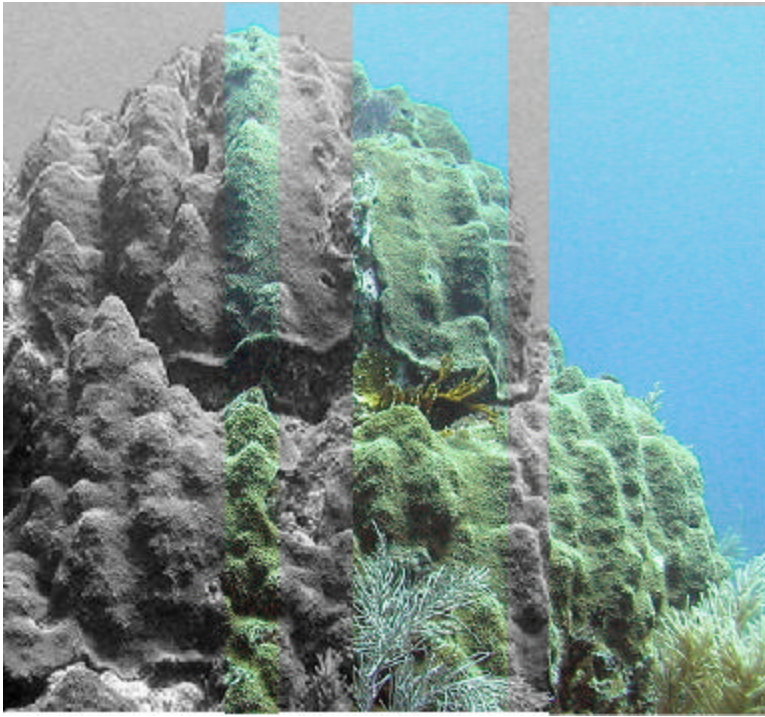
Specificity

# MONOMORPHIC

# POLYMORPHIC

Environmental Gradient





# Seasonal surveys

## Florida and Bahamas

- cell counts
- chlorophyll
- protein
- florescence
- symbiont identity\*

Are there seasonal transitions\turnover in symbiont population type?

# Seasonal observations

*M. annularis* species complex associates with 5 identifiable types  
- B1, B10, C3, C12, D1a

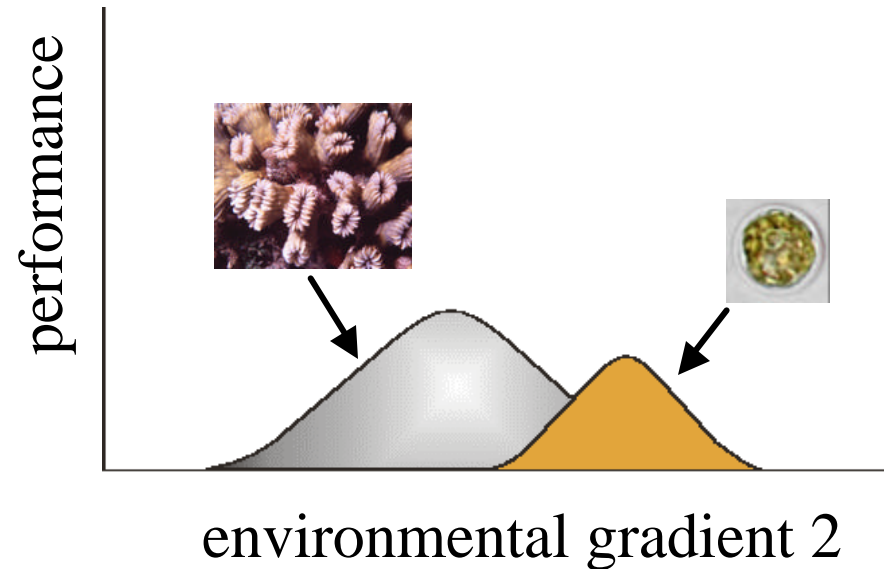
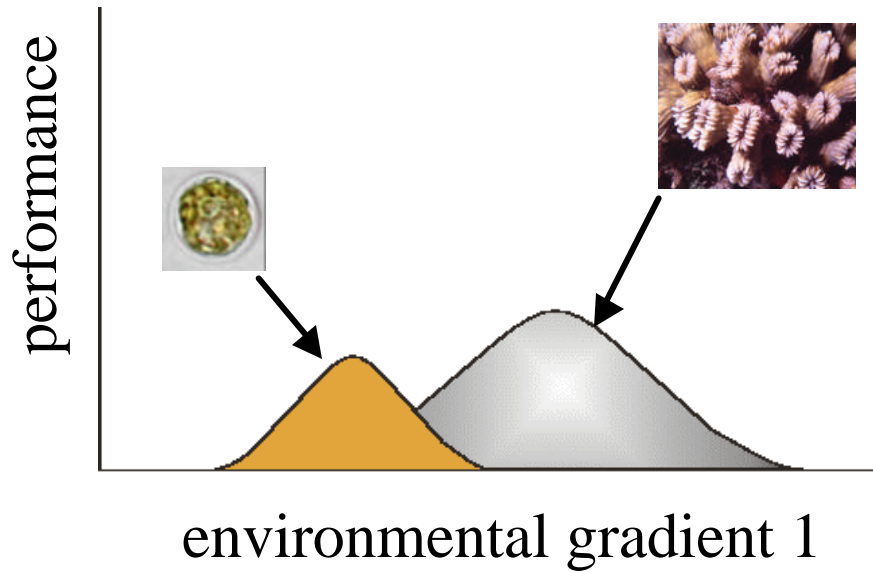
In Florida, symbiont transitions have occurred in some host species.  
- some changes appear to be seasonal.  
- some are longer term.

Differences between the Bahamas and Florida stresses the importance of environmental data.

Bleaching is not required for host symbiont recombination.

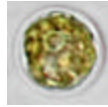
# Physiology of the holosymbiont

# Tolerance curves for coral host and dinoflagellate symbiont



# holosymbiont

Symbiont 1



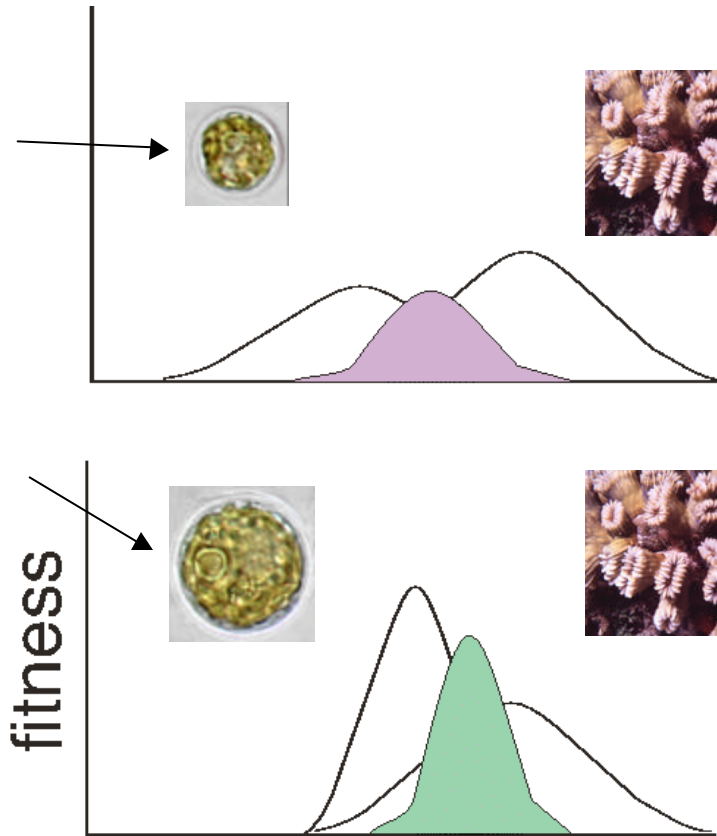
Coral 1

Symbiont 2



fitness

environmental gradient



There are approximately 60 species of Caribbean coral

There may be hundreds of holosymbiont combinations

Eco-physiological diversity is probably far greater than just coral diversity.





How will reef communities look if the global warming trend continues?



It may largely depend on the relative susceptibilities of holosymbionts to thermal stress?

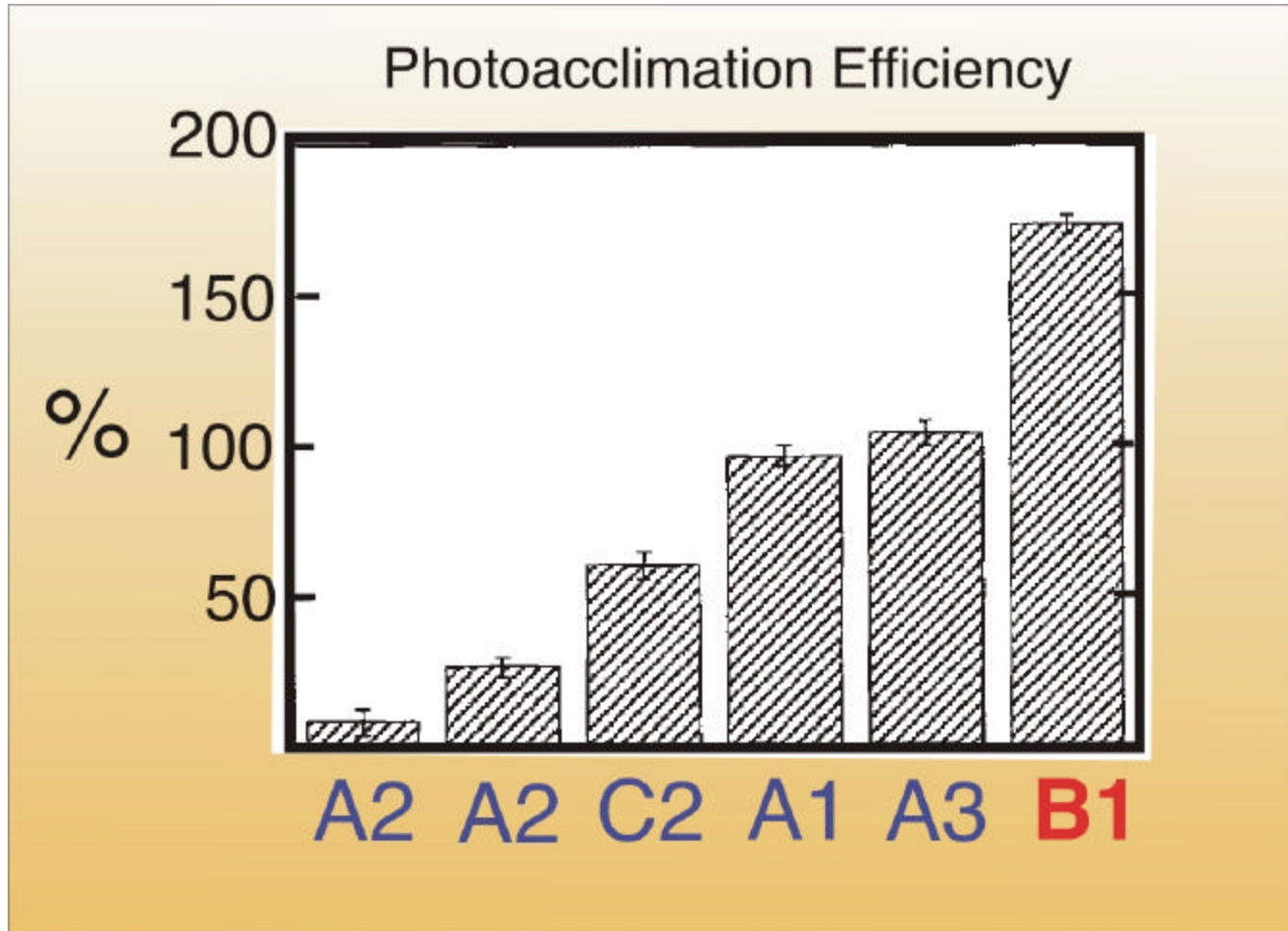




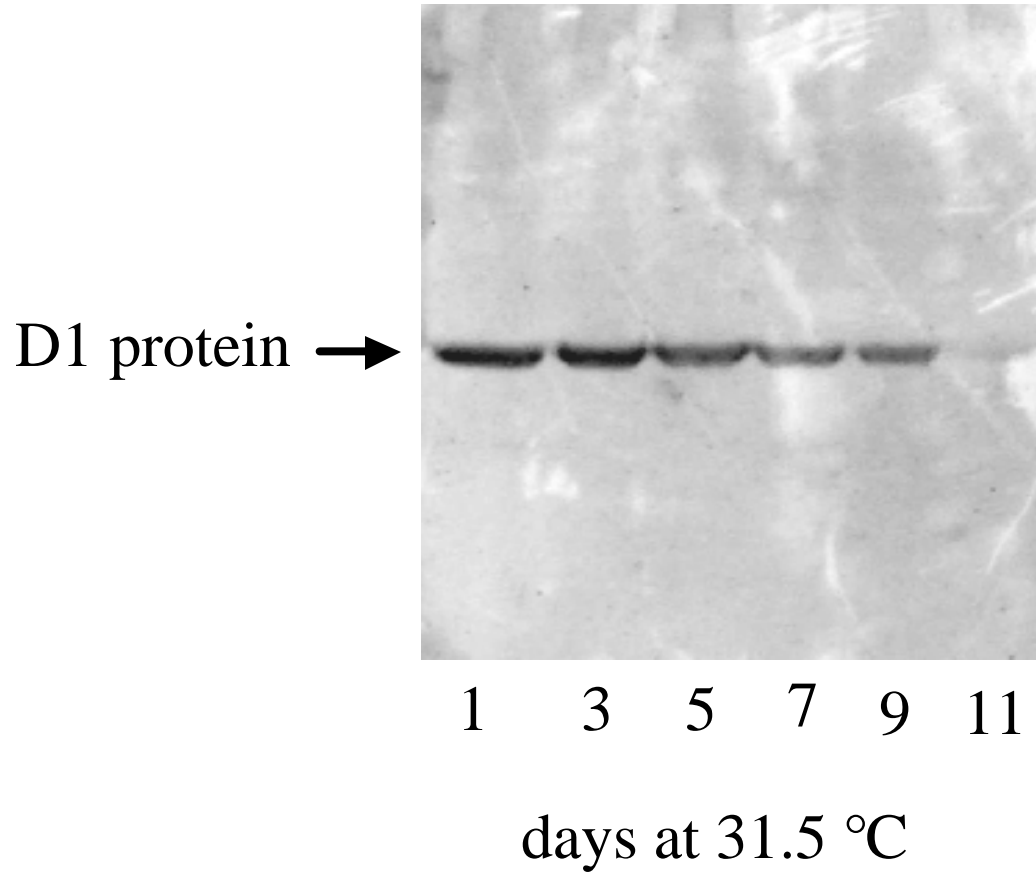
*Porites* spp.

Bleaching resistance in some corals may be explained by the presence of a specific symbiont species.

# PHOTOPHYSIOLOGY



## Resilience of photosystem II





## Future Needs

Continue field observations

Establish good consistent protocols for comparative work?

- photosynthetic performance
- calcification and growth rate
- recovery after stress
- etc...

Collaborations are essential